UNITED STATES COAST GUARD

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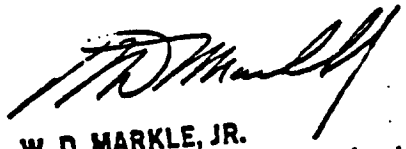
NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 6-80

Subj.: Guide to Structural Fire Protection Aboard Merchant Vessels

1. PURP0SE. This guide has been prepared to explain the Coast Guard structural fir. protection regulations. It is intended to serve as an explanation of accepted practices which have been found to comply with the intent of the regulations.

2. DIRECTIVE AFFECTED. This Circular and enclosed guide supersedes the previously issued NVC 10-63.

3. DISCUSSION. Enclosure (1) is a guide detailing typical, acceptable methods of complying with the Coast Guard structural fire protection regulations. It must be remembered that other alternatives may be equally acceptable based upon specific application. This guide is intended as an illustrative aid for Coast Guard technical units, marine inspectors, materials manufacturers, vessel owners, designers and others who deal in the design and approval of shipboard structural fire protection. Nothing contained in. this guide shall be taken as amending the applicable requirements set forth in the Code of Federal Regulations, nor as limiting the authority of the Officer in Charge, Marine Inspection in his determination of acceptable materials and installation methods.



W. D. MARKLE, JR.
Acting Chief, Office of Merchant Marine Safety

Encl: (1) Guide to Structural Fire Protection Aboard Merchant Vessels

Ce: Baltimore (75); San Francisco, Mobile, Guan, Pittsburgh. Providence. Norfolk (50); Galveston (30); Cleveland, Portland 0R, Sturgeon Say (25); San Diego, Savannah, Buffalo, Corpus Christi (20); Tampa, Milwaukee, Nashville, Detroit, Toledo, Anchorage (15); Portland ME, Duluth, Charleston,. Huntington, Minneapolis-St Paul (Dubugue). San Juan (10); Juneau, Cincinnati, Memphis, Wilmington, Paducah, Albany (5) extra

Cm: New Orleans (250); New York (200); Seattle (100); Houston (50); Terminal Is (LA-L3). Philadelphia (40) extra

GUIDE TO STRUCTURAL FIRE PROTECTI0N ABOARD MERCHANT VESSELS

1. Introduction

This guide is intended to clarify the structural fire protection requirements for merchant vessels contained in Title 46 of the Code of Federal Regulations. It is generally accepted that the regulations without explanation may be insufficient for the comprehension of the total scope and intent of the Coast Guard'5 structural fire protection system. This guide is a clarification and interpretation of the regulations, and in no way changes or modifies the applicable requirements

Requirements for structural fire protection on board merchant vessels have been formulated as a complete system, and for total effectiveness, all aspects of the system must be incorporated into a vessel design. It is important to realize that the primary function of structural fire protection is to provide for the life safety of personnel on board a vessel during periods of fire exposure and must be considered from a different viewpoint than life safety in holdings. Generally, in a building. escape from a fire zone is made in the opposite direction of flame spread; however, on board vessels, escape-to the -lifeboats is often in the same direction as flame spread.

Aboard vessels, potential high fire risk areas such as machinery spaces and cargo spaces must be separated from accommodation areas by structural and thermal boundaries. within accommodation areas, means of escape including corridors and stairways must be adequately protected. It is important that these escape routes are correctly protected and placed and, further, that the integrity of each is maintained at all junctions and penetrations. In the following sections each component of the structural fire protection system will be explained and the component’s function within the total system will be more clearly defined. However, the total structural fire protection system must be incorporated in the vessel's structure for optimum safety.

1.1 History and Development

Structural fire protection is a "Life Safety system" contained in the current vessel regulations. The development of this system can be traced to casualties in the early twentieth century. The sinking of the S. S. TITANZC on April 14, 1912 heightened public concern for safety of Life at Sea, and the heavy death toll experienced in this tragedy was a primary cause for the calling of an international conference for the safety of life on the high seas. In 191t', the first International Conference on Safety of Life at sea was held in London. The recommendations of the conference concerned vessel subdivision and minimum requirements for lifesaving devices 3 however no mention was made of structural fire protection requirements. Because of the onset of world war I, the provisions of this Convention were never fully implemented.

In 1929, a second conference promoting safety of life at sea was held. The purpose of this conference was to continue development of an international standard for the safety of passenger vessels as originally begun in 1914. On May 31, 1929, the "Convention for the safety of Life at Sea" was completed. only one segment of this convention specifically addressed structural fire protection requirements. Regulation XVI required the fitting of fire-resisting bulkheads above the weather deck. The purpose of this requirement was to confine any outbreaks of fire into zones which would not exceed 40 meters in length. This figure was apparently chosen to coincide with every second watertight bulkhead. The fire-resisting bulkheads were required to be constructed of “metal or other fire-resisting materials effective to prevent for one hour, under the conditions for which the bulkheads are to be fitted in the ship, the spread of fire generating a temperature of 1500^0F at the bulkhead.”

Seven years elapsed prior to the Convention's ratification by the United States. Impetus towards the ratification of this document and the development of structural fire protection regulations occurred in 1934 when the U.S. flag passenger vessel MORRO CASTLE burned off the coast of New Jersey, causing the death of 124 persons. Public reaction to this tragedy convinced the U.S. Senate Committee on Commerce to create a special subcommittee to investigate the MORRO CASTLE tragedy and to develop recommendations for life safety standards aboard U.S. vessels. The Subcommittee was divided into groups assigned to deal separately with the various elements of life safety at sea. The investigation of fire protection measures was assigned to the Subcommittee On Fireproofing and Fire Prevention under the leadership of George G. Sharp, a prominent naval architect. In its reports the Subcommittee noted “The first problem confronting the committee was the question as to what general method of fire control might be the most practical combination of effectiveness and simplicity. past experience having demonstrated the vulnerability of complex automatic and manually controlled systems of detection and extinction. widely spaced fire doors, etc.. it was agreed that, if possible and economically practicable. the most foolproof solution to the problem would be construction of such nature that it would confine any fire to the enclosure in which it originated.” The Subcommittee had for consideration the 1929 SOLAS convention which required “fire-resisting bulkheads;" however, a precise definition or standard test for “fire-resisting bulkheads” was not included in the convention requirements.

To develop a comprehensive definition for “fire-resisting bulkheads,” the Subcommittee decided to conduct a series of full-scale shipboard fire tests to evaluate different methods of construction. A test ship, the S.S. NANTASKET, was procured from the Reserve Fleet on the James River. In mid-1936, numerous fire tests were conducted which singled out the performance of one type construction '1tili:ing steel plate and asbestos composition panels. This construction technique was recommended by the Marine Section of the National Tire Protection Association (NFPA), and included two types of “fire-resistive" bulkheads. Class A-I bulkheads, intended fat use as fire screen or main vertical :one bulkheads. and Class B bulkheads for stateroom boundaries. class A-1 bulkheads were metal bulkheads which were lined or insulated effectively to maintain structural integrity and prevent the spread of fire to the unexposed side of the test panel when subjected to a standard fire test for one hour. Class B bulkheads were incombustible materials which. could maintain structural integrity and prevent fire spread of fire to the unexposed side of the test panel when subjected to a standard fire test for thirty minutes. The standard fire test also recommended by the Marine Section of the NFPA was the laboratory fire-endurance test used by the National Bureau of Standards, which had been adopted as a standard test method in 1918 (ASTM E-119)

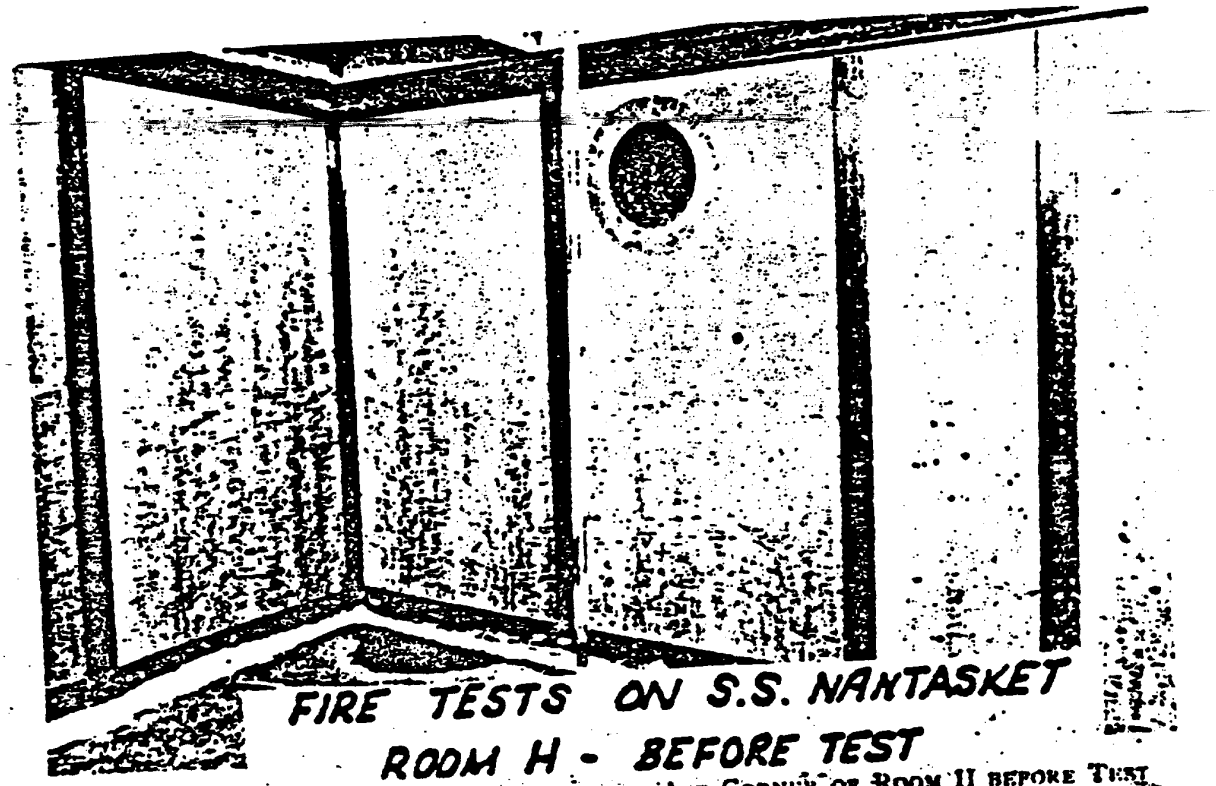
During the S.S. NANTASKET tests, temperatures were recorded to compare the flame temperature in the test rooms to the temperatures in the standard laboratory test furnance. initially, the tests were conducted using clothing and typical furnishings as a fuel source. very poor combustion occurred, and cord wood was then substituted as a fuel in the remainder of the tests. To approximate the B.T.U. content of the clothing and furnishings, a fuel load of 5 lbs/ft^2 was used. With this configuration, temperatures equivalent to those generated in the standard laboratory. test were noted.

Based upon the test results, the Subcommittee reported to Congress, “It would be impossible to fireproof a modern passenger ship by the methods used ashore." During the NANTASKET testing, it was determined that certain materials commonly used for building construction ". . . gave of f such quantities of fumes that it was found impossible to approach even a minor fire to extinguish it. During the course of experiments, a form of construction was developed in which combustible material was eliminated to such an extent that combustion cannot be sustained by any part of the ship’s structure."

As a result of the recommendations presented by the Subcommittee in Chapter IV of Senate Report No. 184, the United States Congress ratified the 1929 convention for the Safety of Life at sea, and amended the United States Code to require U.S. vessels to employ "fire-retardant material in their construction so far as is reasonable and practicable.'" Although it was not clearly defined, the type construction that was utilized in the S.S. NANTASKET tests was intended.

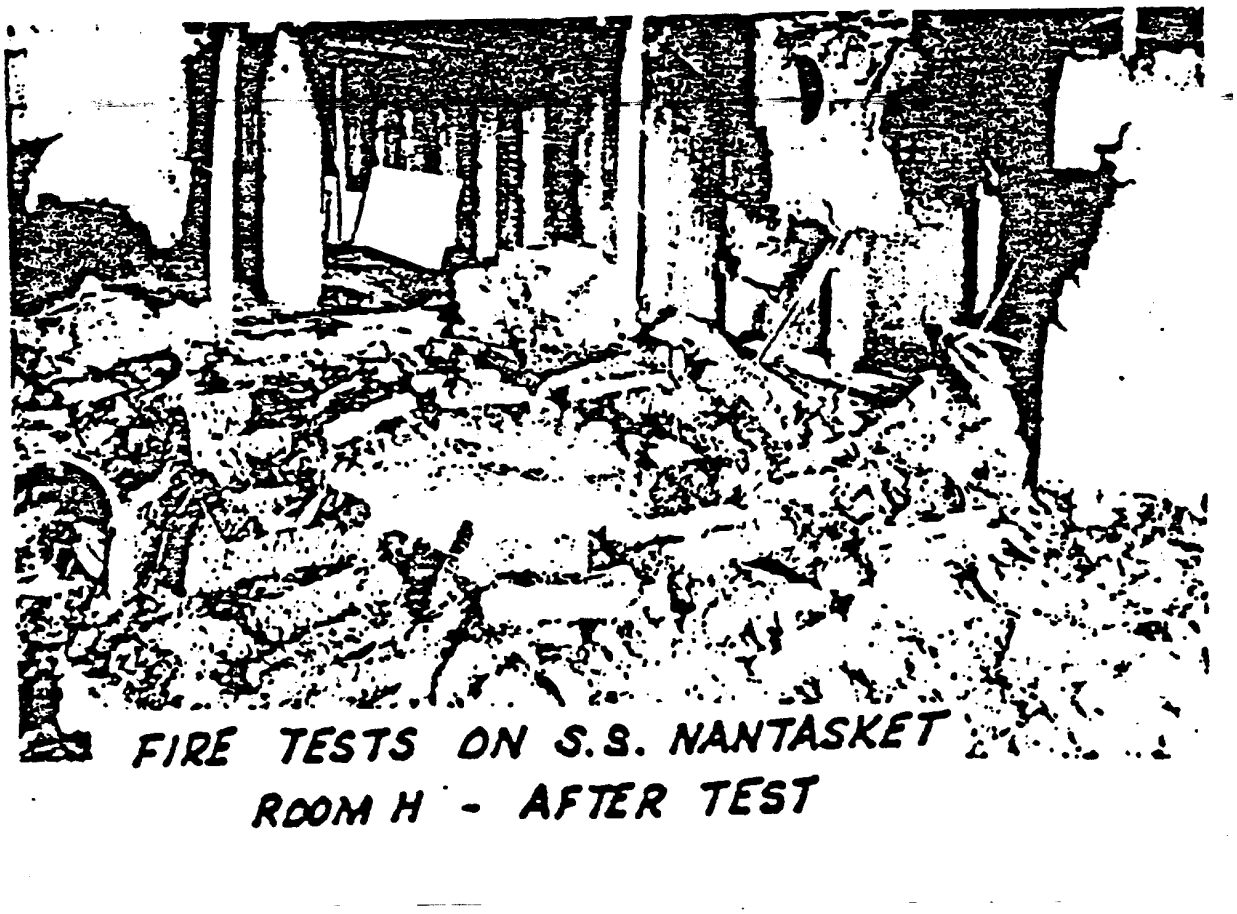
Under the authority of 46 U.S.C. 369, the Secretary of Commerce promulgated Order #42 on July 17, 1940, creating Part 144 of Title 46 of the Code of Federal Regulations (Subchapter M). paragraph 144.4 (a) of Subchapter M required interior boundaries to be "constructed of Class A-1, A, or B fire-retardant materials." Class A-1 bulkheads were required to be steel, lined or insulated with sufficient incombustible materials to prevent the average temperature on the unexposed side of the test bulkhead from rising more than 250^0F or any single point temperature from rising more than 325^0F in one hour when subjected to the standard fire test. Class A bulkheads were required to be steel and to withstand the standard fire test for one hour with no temperature rise limitations. Class B bulkheads were required to be incombustible materials capable of withstanding the standard fire test for 30 minutes and to be capable of preventing the aforementioned temperature rise limitations for 15 minutes. The terms “fire retardant” and incombustible” were used without precise definitions. Unfortunately, there were materials that could be considered fire-retardant and which, in certain configuration, could pass the standard fire test, but did not have the equivalent noncombustibility properties as steel or asbestos. Because of the lack of a specific test method, materials were approved which had the potential to greatly contribute to the fuel load of a protected space. It was not until the end of World War II that a specific test was developed to classify materials as incombustible. In 1949, the Coast Guard adopted standard 46 CFR 164.0009 for incombustible materials based upon research conducted at the National Bureau of Standards by N.P. Setchkin and S.H. Inberg.

During World War II, the need for lighter-weight ships super structured had brought about the use of aluminum bulkheads on U.S. Naval vessels. After the war, aluminum bulkheads were proposed for staterooms aboard passenger vessels. It was argued that aluminum bulkheads would be an acceptable substitute for the heavier asbestos composition panels although the aluminum panels might not withstand the standard fire test. The basis for this argument was the fact that aluminum, which has a very high thermal conductivity, will dissipate heat rapidly; secondary, it was felt that the intensity of the fires in the NANTASKET tests was due to the cord wood fuel source and, as such, did not represent actual conditions. It was maintained that the typical contents of a stateroom could not constitute a fuel load capable or producing a fire equivalent to the standard laboratory test, or even to cause melting of the bulkheads. In 1947, a full scale aluminum stateroom burnout test was conducted in conjunction with the naval architecture firm of Gibbs & Cox, inc. and the National Bureau of Standards. The stateroom test was conducted in a mock-up stateroom using passengers as a fuel source. This test verified the results of the NANTASKET tests, and showed that a fire involving only typical furnishings is capable of generating the same temperatures as the laboratory fire test furnace. The stateroom test also showed that uninsulated aluminum bulkheads cannot provide the same degree of fire protection as asbestos composition panels.



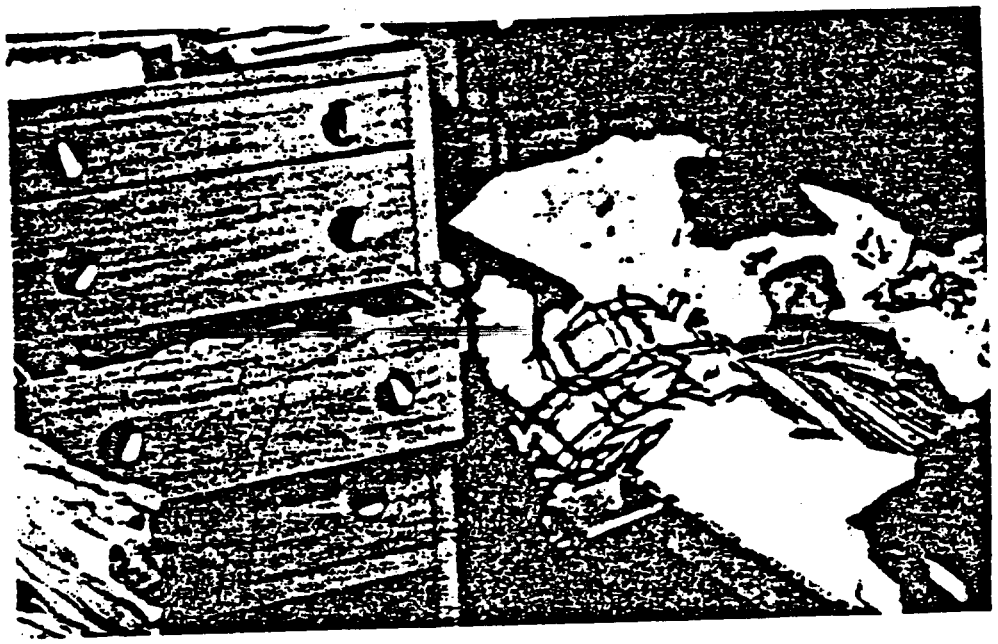
TEST NO. 3.—INTERIOR VIEW, OUTBOARD AFT CORNER OF ROOM H BEFORE TEST

1936 S.S. Nantasket Fire Tests-Room H Before Fire



1936 S.S. Nantasket Fire Tests-Room H After Fire

1947 STATEROOM FIRE TESTS



Fuel Load Consisting of Typical Furnishings

Ignition of Combustibles at Start Of Tests

The new maritime technology developed during World War II was the cause for a third international Conference on the safety of Life at sea during April of 19118, to upgrade the 1929 SOLAS convention. The United states proposed the incorporation of fire protection techniques contained in 46 CFR Subchapter M. Because the materials used for U. B. flag construction were not. available world-wide, and because several nations felt that active fire protection systems were equivalent to passive fire protection. three alternate methods of shipboard fire protection appeared in the 1948 convention. Method I was the technique proposed and employed by the United States. Method II, proposed by the United Kingdom. advocated the use of sprinklers with no restriction on the combustibility or fire endurance of compartment bulkheads. Method III, proposed by France, made use of a limited amount of fire-resisting bulkheads in conjunction with a fire detection system. The 1948 convention came into force in the united States on 19 November 1952. To implement this document. and to also revise the passenger vessel inspection regulations into one subchapter, the Coast Guard withdrew Part 144 and created a new Part 70 (Subchapter H -- passenger vessels) in Title 46 of the Code of Federal Regulations. The regulations written for this new subchapter are basically those in effect today.

In the new subchapter u changes were made regarding bulkhead fire endurance ratings. The old class A-1 bulkheads are now A-60, the Class A bulkheads were changed to A-0, and the Class 3 bulkheads are now 3-15. TWO new categories of bulkheads were created. Claus A-30 bulkheads were an intermediate Class A bulkhead. Class 3-0 bulkheads were created because the former Class 3 bulkhead panels had an inherent fifteen minute fire endurance rating; however. unless certain connector systems or .3-posts" were used. a heat transfer through the connectors occurred. It was felt that if these bulkheads with inferior connection were installed next to spaces with very low fuel loads such as toilet spaces. a B-0 rating would be acceptable.

The 1948 Convention was followed by two later conventions, SOLAS 60 and SOLAS 74, which added further improvements to international structural fire protection requirements. The present-day Coast Guard structural fire protection philosophy is based upon many full scale tests and experiences. and can be summarized by the following SOLAS principles:

(1) Division of passenger vessels into main vertical zones by thermal and 5tructural boundaries

(2) Separation of accommodation spaces from the remainder of the ship by thermal and structural boundaries;

(3) Restricted use of combustible materials;

(4) Detection of any fire aboard passenger vessels in the zone of origin;

(5) Containment and extinction of any fire in the space of origin: and

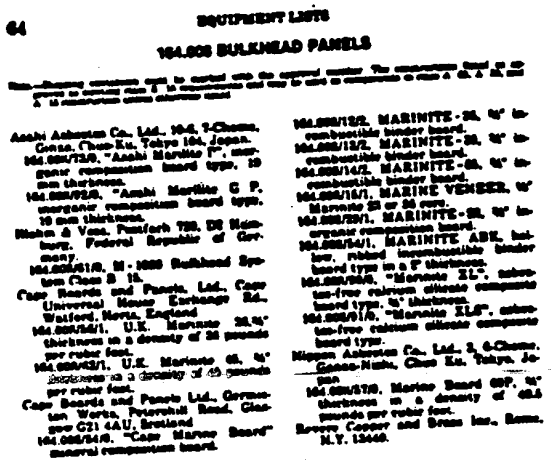
(6) protection of means of escape or access for fire fighting.

1.2 Type Approvals

All approved structural fire protection materials for use on board merchant vessels are listed in the Coast Guard's Equipment Lists, CG-190. In order for a material to be listed as "approved11. it must first be tested to the applicable Coast Guard specifications. initially, a manufacturer must apply to Commandant (G-MMT-3/TP12), 2100 2nd St. S.W., Washington. D.C. 20590, and

request approval for a specific product. Appropriate information or small samples should be included with this request so that a preliminary evaluation of the material can be made. If the material appears acceptable for testing, the manufacturer is notified of the specific test procedures and approximate costs before approval tests are conducted. Currently, the National Bureau of Standards. and Underwriters Laboratories, inc. of Northbrook, III., are Coast Guard-recognized test laboratories for testing of structural fire protection materials. After successful approval testing. the product is granted an approval number, which is listed in the Coast Guard Approved Equipment Card File, and a notice is published in the Federal Register. The card file is the most recent listing of approved materials. CG-190 is updated only periodically, and it is possible for a material to be approved and not appear in CG-190. Each Coast Guard marine safety unit has an approved equipment card file.

Materials which are required to be "fire-resistant materials" are not tested to Coast Guard specifications. but are accepted on the basis of test reports from independent testing laboratories. Approval of these materials is not done at Headquarters, but is done on a case-by-case basis by the district commander (mmt).



64 EQUIPMENT LISTS

164.005 BULKHEAD PANELS

CG-190-Coast Guard Approved Equipment Lists

ISSUED TO	UNITED STATES COAST GUARD CERTIFICATE OF APPROVAL	EXPIRATION DATE	APPROVAL NUMBER
Mt. Airy Fabric Corp. Box 1212, Stevens Penna. 17578	for Fire Retardant Fabrics	1 June 1982	164.011/34/0

DESCRIPTION

Mt. Airy Fabric Corp. drapery and seat upholstery materials described in U.S. Coast Guard test report number AD 16710 dated 1 May 1977 .

REMARKS

Plant located in East Petersburg, Penna.

IDENTIFYING DATA U.S. Coast Guard report AD 16710 dated 1 May 1977

THIS IS TO CERTIFY THAT the above named manufacturer has submitted to the undersigned satisfactory evidence that the item specified herein complies with the applicable laws and regulations as outlined on the reverse side of this Certificate, and approval is hereby given. This approval shall be in effect for a period of five years from the date hereon unless sooner canceled or suspended by proper authority.

BY DIRECTION OF THE COMMANDANT

Given Under My Hand This 1st Day of June 1977, at Washington, D. C.

Chief, Merchant Marine Technical Division, U. S. C. G.

DEPT OF TRANSP., USCG, CGHQ 16030 (Rev. 9-67)

United States Coast Guard Certificate of Approval

1.3 Definitions

Accommodation Area - A group of accommodation .paces and interconnecting corridors or spaces.

Accommodation Spaces - Those spaces including:

- Public spaces
- Halls
- Dinning Rooms
- Messrooms
- Lounges and Cafes
- Public sales rooms
- Staterooms, both passenger and crew
- Barber shops and beauty parlors
- Offices dispensaries
- Washrooms and toilet spaces
- Isolated lockers and storerooms in accommodation areas
- Isolated serving pantries in accommodation areas
- Medical treatment rooms
- Small laundries containing only tubs, washing machines, or small domestic type electric dryers
- Cleaning gear lockers

A-Class Division - A-Class divisions are bulkheads or deck. constructed of steel or equivalent metal, suitably stiffened and made intact with the main structure of the vessel. A-Class divisions are capable of preventing the passage of flame and smoke for one hour, and may include approved insulations, bulkhead panels, or deck coverings to limit the transfer of heat through the division.

A-Class Door - An A-Class door is the type door required in an division. These doors are not fire-tested, but are constructed of approved materials, arranged in a similar fashion as for A-Class divisions. A-Class doors are usually follow metal, and some types are filled with approved structural insulation. See section 2e8 below for more details.

Approved Deck covering - Materials applied on top of a deck as a finishing or leveling surface which also form a part of the deck's structural fire protection. Approved deck coverings are tested in accordance with 46 CFR 164.006. Rugs and overlays are not deck coverings. See section 2.4 for more details.

Approved 'Materials - Approved materials are those which meet the required criteria set forth in Coast Guard regulations as follows:

- Deck coverings - 46 CFR 164.006
- Structural insulations - CFR 164.007
- Bulkhead Panels - 46 CFR 164.008
- Noncombustible materials - 46 CFR 164.009
- Fabrics (Tentative) - 46 CFR 164.011
- Interior Finishes - 46 CFR 164.012

Automatic Fire Damper- A duct closure device, held open by a fusible link which melts at a pre-set temperature. After the fusible link melts, the damper automatically closes, sealing off the duct. These dampers are designed to prevent the spread of fire and smoke through ductwork and are required to be manually operable as well. Similar devices are operated by pressure switches on carbon dioxide and Nalon 1301 systems to seal of f protected spaces in order to maintain an extinguishing concentration of agent. section 3.LI contains specific details for automatic and manual fire dampers.

B-Class Division - B-Class divisions are divisions constructed of noncombustible materials and made intact from deck to deck or to a continuous B-Class ceiling on both sides, the vessel's shell, or other boundaries. They are required to prevent the passage of flame, but not smoke, for thirty. minutes.

B-Class Door - A B-Class door is the type door used in 3-Class divisions. These doors may be metal or other noncombustible material. Wire-inserted glass and vent grilles may be installed in these doors. For more information, see section 2.8.

Bulkhead Panel - Bulkhead panels are sections of noncombustible binder board which are fitted together to form a division. Where these panels are used as a B-Class division, they alone form the bulkhead. Each panel is joined to two adjacent pane 15 and to the overhead and decks with approved joiner construction.

Category A Machinery Space - A Category A machinery space is any space including trunks and ducts to such a space that contains:

(a) Internal combustion machinery used for main propulsion;

(b) Internal combustion machinery used for purposes other than main propulsion where the total aggregate power is at least 500 brake horsepower (373 k.w.);

(c) Internal combustion machinery that uses a fuel that has a flash point of less than 43.3^0C (110^0F); or

(d) One or more oil fired boilers or oil fuel units.

C-Class Divisions - C-Class divisions are bulkheads or decks, constructed of noncombustible materials, which meet no requirements relative to the passage of flame nor the limiting of temperature rise. Aboard tank vessels and cargo vessels, C-Class divisions may be used for stateroom boundaries which do not form corridors.

C-Class Door - A C-Class door is the type door installed in a C-Class division. These doors must be constructed of non-combustible materials.

Cargo Space - Those spaces including:

- Cargo Holds
- Lockers
- Refrigerated Cargo spaces
- Cargo Oil Tanks
- All trunks leading to and from the above listed spaces.

Ceiling - A ceiling is a horizontal division within a space for the purposes of decoration, acoustics, or fire protection. A ceiling is not considered part of the overhead structural deck. ceilings are constructed of non-combustible materials. combustible moldings, veneers, or trims may not extend into the hidden space above the ceiling

Combustible Material - Any material which fails the noncombustibility test for materials on board merchant vessels as set forth in 46 CFR 164.009.

Continuous B-Class Ceiling - This is a ceiling which forms a, structural fire protection element between two decks. A continuous B-Class ceiling is used in lieu of extending B-Class bulkheads from deck to deck in accommodation and service areas. These ceilings are tested to46 CFR 164.008 requirements in addition to being non-combustible.

Control Station - control stations are those spaces including:

- spaces containing the emergency source of power
- spaces where, a continuous watch is maintained and where navigating and radio equipment is located
- spaces where fire control equipment is centralized such as CO_2 rooms.

Note: Machinery space engineering control stations are not included in this definition..

Dead End Corridor - A dead end corridor is a passageway from which there is only one route of escape. see section 3.3 for additional information.

Deck - A deck is a horizontal division in a vessel's structure. Decks in certain areas provide structural fire protection. see section 3.2 for a more complete discussion.

Draft Stop - A draft stop is a division or “curtain” installed between ceilings or linings and the vessel's structure. The purpose of a draft stop is to prevent the spread of fire and smoke in concealed spaces. See section 3.1 for additional information.

Exit -A means of egress from a space. It can be a door or a corridor leading to a door or another space with a door, etc.

Fire-Resistant - A descriptive term applied only to shipboard materials such as fabrics, paddings, and draperies. It denotes a considerably lower degree of fire protection than non-combustible, yet maintains a degree of protection higher than that of ordinary combustible materials used aboard vessels. The intent of specifying fire-resistant furnishings is to provide materials with a lower probability of ignition and flame propagation. It should be noted that this term does not, in all cases, denote the identical degree of fire protection used in building construction. See section 2.6 for additional information.

Furnishings - Furnishings are the contents of rooms, such as desks, chairs, tables, dressers, sofas, draperies, rugs, etc. See section 2.6 for additional information.

Incombustible - See non-combustible.

Incombustible veneers and trim - Materials which are approved under 46 CFR 164.012 or 46 CFR 164.009.

Integrity - The basic, fire-resisting ability of a division. For example; to maintain the integrity of a bulkhead, openings cut for the passage of electrical cables must be 8ealed to prevent the transmission of heat and smoke.

Interior Finish - An interior finish is any coating or veneer applied as a finish to an approved bulkhead panel. non-combustible material, or structural insulation on a bulkhead or ceiling. This includes the visible finish. all intermediate materials. and all application materials. adhesives, etc.

Joiner Construction - Joiner finished interior of compartments. The main structure of a vessel is subdivided by joiner work to form livable, workable, and decorative spaces Bulkhead panels, ceilings and connectors (a joiner system) are the components of joiner construction.

Machinery spaces - Machinery spaces are those spaces including:

- Category A machinery spaces
- spaces containing propelling machinery
- Poiler spaces
- spaces containing fuel oil units, steam, or internal combustion machinery
- spaces containing generators or electrical motors and auxiliaries (NOTE: spaces containing the emergency source of power are considered control stations).
- oil filling stations
- spaces containing refrigeration machinery
- spaces containing ventilation and air conditioning machinery
- All trunks leading to and from the above listed spaces.

Main Vertical Zone - Main vertical zones are sections of a vessel the mean lengths of which do not exceed 131 ft (40 m) The hull, superstructure, and deckhouse of passenger vessels are required to be divided into main vertical zones by steel or equivalent metal bulkheads or decks to prevent the spread of fire throughout the vessel. Main vertical zone divisions also contain a fire to permit attempts at extinguishment.

This requirement was originally derived from the 1929 SOLAS convention.

Main Vertical Zone Bulkhead/Deck - These are at least A-Class divisions that separate one main vertical zone from an adjacent main vertical zone.

Means of Escape - A means of escape is a route by which persons may evacuate a space to an area of refuge, such as the lifeboat embarkation area. Exits are a portion of a required means of escape.

Miscellaneous Spaces - Miscellaneous spaces include:

- Fuel and water tanks
- Voids
- Open decks and enclosed promenades. except in way of lifeboat embarkation and lowering areas
- Shaft alleys. when separated from machinery spaces and containing no combustible materials.

Non-combustible Material - Any material approved by the Coast Guard as having successfully passed the non-combustibility test in 46 CFR 164.009. certain materials are considered non-

combustible without testing. See section 2.1 for additional information. NOTE: The word “non-combustible" replaces the term “incombustible."

Overlays - overlays are materials such as wood, and vinyl tiles which are applied to decks for finishing purposes. Within accommodation and service areas, overlays less -than an average 3/8 of an inch (9.5 mm) in thickness need not meet any requirements for combustibility.

Passageways - A passageway is a corridor. Aboard passenger vessels, corridors or passageways over eight feet in width are considered public spaces.

Penetration - A penetration is any opening made in a bulkhead or deck to permit the passage of piping. wiring, remote control shafts, or ventilation ducts. For the purposes of structural fire protection. these openings must be protected to maintain the integrity of the division. see section 2.7 for additional specific information.

Public Spaces - public spaces are spaces aboard passenger vessels including:

- Halls
- Dining rooms
- Lunges
- Cafes
- Other similar spaces accessible to passengers Safety Areas - safety areas aboard passenger vessels include:
- Control stations, including spaces containing the emergency source of power, spaces containing navigating and radio equipment, and spaces where fire control equipment is centralized.
- Stairways and elevator enclosures
- Corridors
- Open decks and enclosed promenades in way of lifeboat embarkation areas.

Service Spaces - Service spaces include:

- Motion picture projection rooms
- Film stowage rooms
- Galleys
- Main pantries and storerooms (including connecting alleyways and stairs)
- Diet kitchens
- Workshops (not part of machinery spaces)
- Large laundries and drying rooms
- Mail and baggage rooms
- Garbage and trash disposal and stowage rooms
- Paint and lamp rooms

Stairtower - A stair tower is a group of stairways enclosed' in a continuous vertical A-Class trunk with self-closing A-Class doors at every level. A stairway is not a stairtower.

Stairway - A stairway is a vertical means of escape between two decks. A stairway does not penetrate mare than one deck. ~ stairway which penetrates only one deck must be enclosed by

bulkheads and a door at least at one level. If it is necessary to have a stairway that penetrates more than one deck, a- stairtower is provided.

Standard Tire Test - A "standard fire test" is one in which a specimen is exposed in a test furnace to temperatures corresponding to the standard time-temperature curve. The specimen resembles, as closely as possible the intended construction and includes, where appropriate, at least one joint. The standard time-temperature curve is defined by a smooth curve drawn through the following points, starting at ambient temperature:

- At the end of 5 minutes - 538^0 ($1{,}0000F^0$);
- At the end of 10 minutes - 704^0C ($1{,}300^0$F);
- At the end of 30 minutes - 843^0C ($1{,}550^0$F);
- At the end of 60 minutes - 927^0C ($1{,}700^0$F);

"Steel Or Other Equivalent Metal" - Where the term "steel or other equivalent metal" is used in this guide, it is intended to mean a material which, by itself or Cue to insulation provided, has structural and fire-en durance properties equivalent to steel at the end of the standard fire test.

Stepped Main Vertical Zone - Where the main vertical zone on one deck is several feet fore or aft of the main vertical zone above or below it. The main vertical zone is "stepped", and the deck area between the two main vertical zones must generally be of a higher class fire endurance (i.e., A-60, A-30, etc.). This is done to insure structural integrity and to prevent the spread of flame and smoke from one main vertical zone to another.

Structural Fire protection - structural fire protection is a means of minimizing the probability of a major fire occurrence and life loss by designing structural elements to confine any outbreaks of fire to as small an area as possible. This is accomplished by specifying fire endurance capabilities of structural elements. Additional items considered are joinerwork details and penetrations of structural elements. Structural or fire insulation refers to insulation employed as a part of the structural fire protection system.

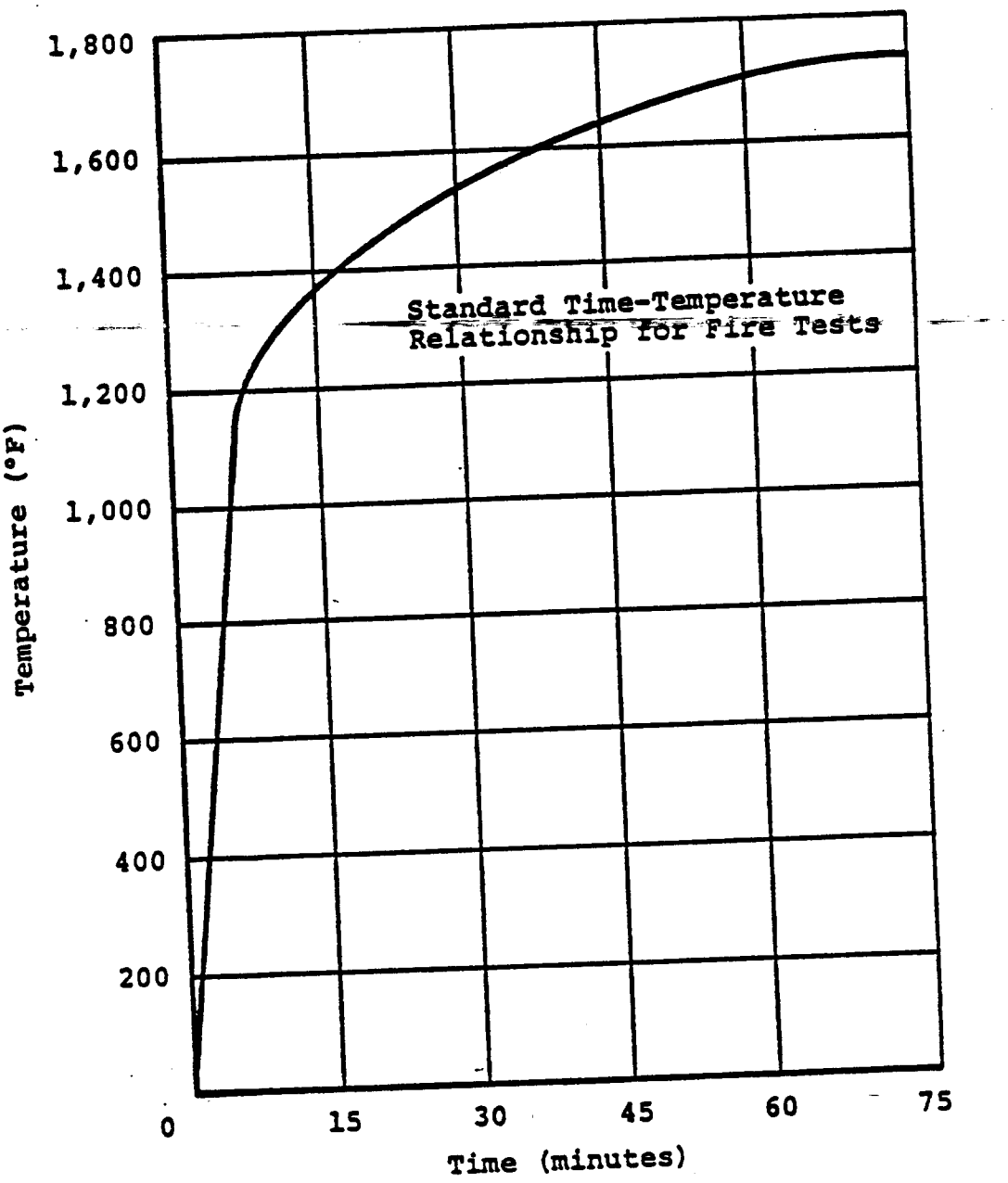
Trunk - Generally, a trunk is a vertical shaft or duct for the passage of pipes, wires. or other devices.

U.L. -The letters "U.L." stands for Underwriters Laboratories, Inc., a not-for-profit independent testing laboratory located in Northbrook, III.

Wire-Inserted Glass - wire-inserted glass is a special type of glass with reinforcing wires cast into the glass. Wire-inserted glass provides more fire endurance than ordinary or tempered window glass. See section 2.8 for additional specific information.

1.4 Submittal of Plans For Approval

For all new construction or major rebuilding, structural fire protection plans should be submitted to the Coast Guard district commander (mmt) reviewing the vessel. The completeness of this plan submittal will greatly aid in timely approval. The submittal should include the following plans:



STANDARD FIRE TEST-Time vs Temperature Control Curve

(1) General Arrangement - This drawing should clearly show the arrangement and type of each space, including the available means of escape. It is important that each space is labeled and bulkhead and deck insulation values noted. The symbols used to note insulation values should be easily distinguishable.

(2) List of Materials - This list should clearly identify all deck coverings, overlays, rugs, carpets, under pads, bulkhead panels, structural insulations, and interior finish materials. The manufacturer and Coast Guard approval number (if applicable) should be indicated for each item.

(3) Ventilation system - This plan should note the general arrangement of all duct work. It should also include the material. and thickness of each duct, and fire damper details and locations.

(4) Joinerwork Details - This plan should show typical bulkhead and ceiling installation details. Section 3.1 contains recommended details for this drawing.

(5) Penetration Details - This plan should show typical penetrations of A-Class bulkheads and decks. It should include piping, wiring, and ventilation details, including material.

2.0 Materials of Construction

2.1 Non-combustible Materials

One of the basic principles of the Coast Guard' 5 structural fire protection philosophy is that the materials from which the vessel and its subdivisions are constructed should not add to the fuel load available for combustion. This requires that the majority of materials of construction within accommodation and service areas be non-combustible. A standard non-combustibility test was developed by the Coast Guard in 1949 as 46 CFR 164.009. This test has remained basically unaltered, except for a recent revision which implemented XMCO Resolution A.270 (VIII). This amendment changed some of the conditions of acceptance for the test data, as well as the configuration of the specimen holder and minor modifications to the furnace.

All materials required to be non-combustible must successfully pass this test except far certain materials which are known to be inherently non-combustible. The following materials came under this consideration, and no certificates of approval are issued for them:

(1) Sheet glass. block glass, clay. ceramics. and uncoated glass fibers.

(2) All metals except magnesium and magnesium allays.

(3) Portland cement, gypsum, and magnesite concretes baling aggregate of sand, gravel. asbestos fibers, expanded vermiculite, expanded or vesicular slags, diatomaceous silica, perlite. or pumice.

(4) When, knitted, or needle punched glass fabric containing not more than 2.5 percent lubricant. (These materials are accepted on the basis of manufacturer's data sheets. Laboratory test reports are not required.)

The non-combustibility test is performed On a much smaller scale than the tests for bulkhead panels or structural insulations. Five cylindrical specimens of approximate dimensions of 45 mm in diameter by 50 mm in height are individually inserted into the test furnace which has been pre-heated to $750^0 \pm 10^0$C. To be considered acceptable, the average temperature measured inside the

furnace must not rise more than 50^0C above the stabilized furnace temperature. Additionally, the observed duration of flaming of each specimen cannot exceed 10 seconds, and the average weight loss cannot exceed 50% of the pre-test weight.

2.2 structural Tnsulations

The basic element of' bulkhead and deck construction is steel plate. Coast Guard experience has shown that steel plate of 11 USSG thickness (.1196 in) or thicker has an inherent fire endurance of at least one hour, and that steel plate of 16 USSG thickness (.0598 in) or thicker has an inherent fire endurance of at least thirty minutes. Without additional insulation, plates of this thickness could be classified as A-0 and 3-0 Class divisions, respectively. Fire endurance, however, is not the sole parameter upon which the structural fire protection system is dependent. To prevent the spread of fire by radiant or conducted heat, some structural divisions must also act as insulators to prevent the transmission of heat to the unexposed side of the bulkhead or deck.

There are basically three ways to achieve this insulating capability on bare steel:

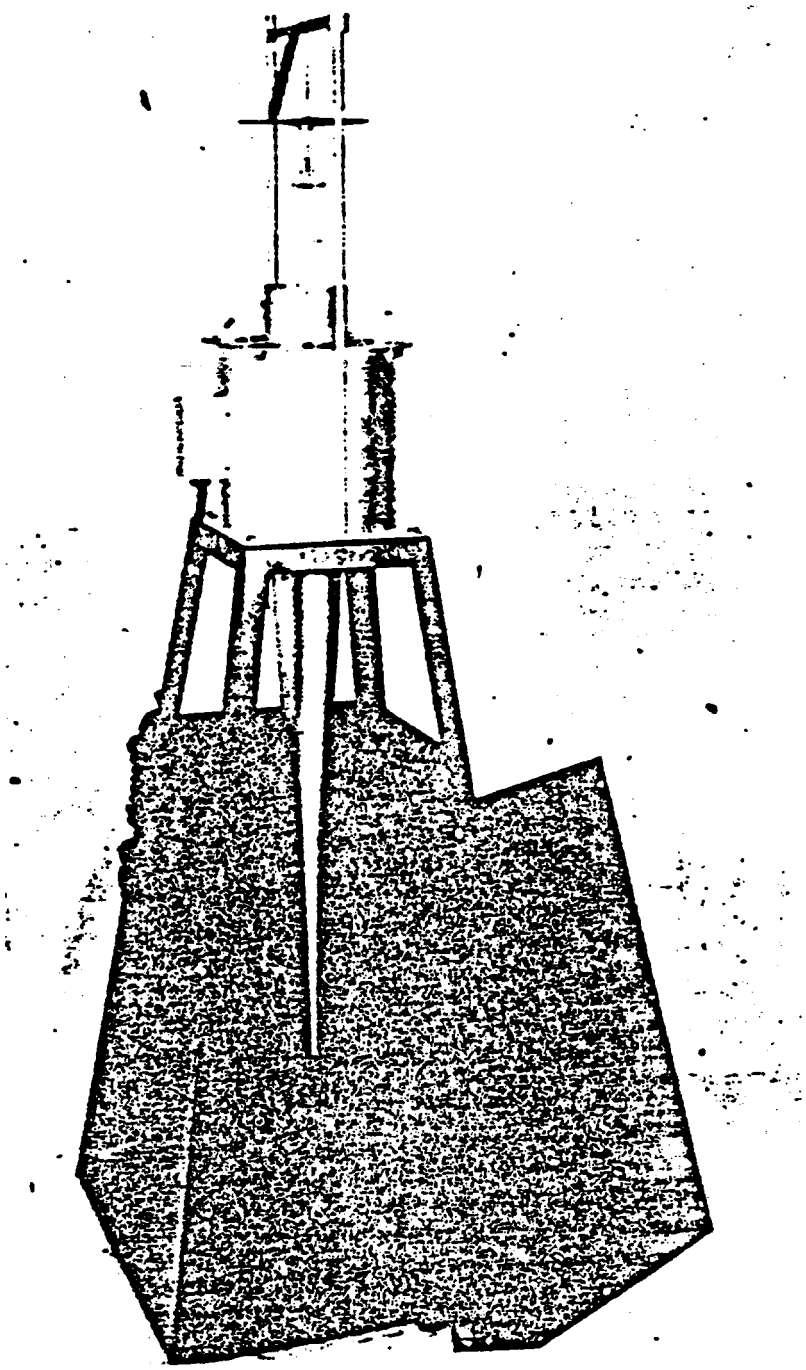
(1) Application of approved structural insulation,
(2) Application of approved bulkhead panels, and
(3) Arrangement of components.

Since the performance of the steel plate has been proven, all that generally needs evaluation are the thermal insulation properties of the structural insulation and bulkhead panels.

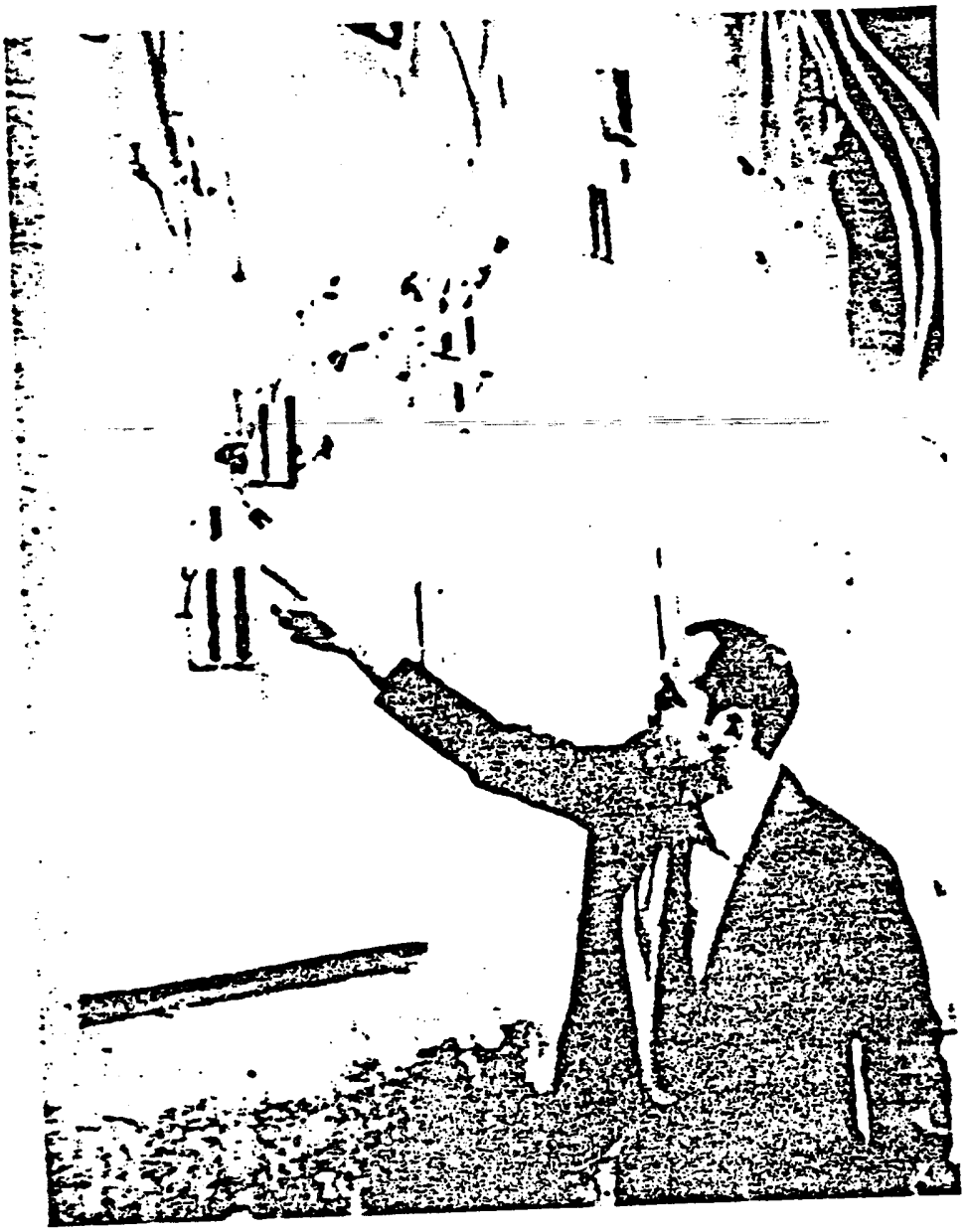
structural insulations are tested to a standard Coast Guard fire test described in 46 CFR 164.007. This test is a furnace test designed to measure only the insulating value of the structural insulation, and not the structural integrity of the assemblies. The basic test procedure requires the mounting of an insulation specimen (minimum dimensions of 40" x 60") on a 3/16 inch thick steel plate. This assembly is then exposed to the standard test furnace. The steel plate is the unexposed side of the assembly from which the temperature rise measurements are taken. To pass the test, the maximum temperature rise at the end of one hour cannot be more than 325^0F (180^0C) above ambient temperature at any one point, and the average temperature rise above ambient temperature of all the test thermocouples must not exceed 250^0F (139^0C).

2.3 Bulkhead Panels

Generally, bulkhead panels are '1 foot by B foot panels of non-combustible binder board. They are tested to the specifications in 46 CFR 164.009. This test is also a furnace test, designed to simulate the identical exposure to the test panel and its joinerwork system as a shipboard stateroom fire. Bulkhead panels are used as B-Class divisions or as components in ~-Class divisions. To be used as a component in A-60 Class construction, the test panel must maintain its integrity during the test for 60 minutes. Bulkhead panels which only remain intact for 30 minutes can only be used in A-30 or A-15 class construction. In all cases except for a 3-0 Class rating, the test panel must meet the thermal insulation requirements for limiting temperature rise for a minimum of 15 minutes. A primary requirement for bath structural insulations and bulkhead panels is that both of these materials must qualify as approved non-combustible materials (~6 CFR 164.009) prior to testing.



Noncombustible Materials Test Furnace



Test Furnace for Bulkhead Panels and Structural Insulations. Note Thermocouple Locations.

2.4 Deck Coverings

Unlike structural insulations and bulkhead panels, deck coverings are not required to pass the non-combustibility test in 46 CFR 164.009, although such materials may be used as deck coverings.

The Coast Guard previously accepted magnesite type deck coverings for use aboard merchant vessels before the S.S NANTASKET tests in 1936. During the test series. several configurations of standard deck coverings were tested. and the conclusion made that the type deck coverings used in general practice would be adequate. Because of uncertainty regarding new type deck coverings, it was determined that unless the organic carbon content of the composite was limited, a potential hazard could exist. Therefore, deck coverings were limited to incombustible materials (which at that time were not subject to test) such as magnesium oxychloride cements. In answer to industry requests, a test method was later developed to evaluate deck coverings containing a minimal organic content. 46 CFR 164.006, implemented in 1953, permits a maximum organic carbon content of .12 grams/cubic centimeter. This test method also contains a smoke production test. The implementation of the new passenger vessel regulations in 1953 required that some method also be available for determining the fire endurance of decks. 46 CFR 164.006 therefore includes a requirement that a 12 inch by 27 inch specimen be exposed to a standard fire endurance test.

2.5 Interior Finish

The interior finish applied to shipboard compartments is important because the spread of flame and the generation of smoke or other toxic gases is initially dependent upon the properties of the interior finish materials. Approved interior finish materials are tested in accordance with LI6 CEP 164.012. Table 2.5 lists the requirements for interior finish materials within accommodations and service areas. The maximum permitted thickness of these materials is .075 inches. If a thicker finish is desired, the use of any material approved in accordance with 46 CPR 164.009 is acceptable. In the event that paint is used as the finish, the regulations permit a reasonable number of coats of paint. It should be noted that a specific paint thickness has not been specified. This permits evaluation on an individual basis.

Materials approved under 46 C.TR 164.012 are tested to A standard E-84. Approved materials must have a flame spread of 20 or less and a smoke developed rating of 10 or less. !f an interior finish material is mounted with an adhesive, the test specimen must be mounted in the furnace with the adhesive recommended by the manufacturer. The approval of the interior finish is then valid only if installed with the adhesive used -in the test. The adhesive is noted on the material's approval card. Materials not approved under 46 CFR 164.012, but tested to ASTM standard E-84, can be accepted on a case-by-case basis if the appropriate U.L. reports are furnished to Commandant (G-MMT-3) which certify that the material was tested in a configuration .075" thick or less and has an acceptable flame spread and smoke-developed rating.

The interior finish requirements in the regulations, which are tabulated in table 2.5, apply to all surfaces on bulkheads and ceilings, but not decks. ceiling light diffusers are also considered subject to these requirements; however, an exemption has been permitted to allow plastic diffusers if enclosed in a metal light fixture, and if the total surface of the light diffusers does not exceed 35% of the ceiling area in any space. When installed in stairways, corridors, and control stations, this percentage should not exceed 25% of the total ceiling area.

2.6 Furniture and Furnishings

Room furnishings are an additional subject requiring consideration with respect to shipboard fire protection. In the design and approval of a vessel, attempts are made to minimize the amount of combustible materials contained in the accommodations and service area structure, thereby minimizing the fuel load contribution of bulkheads and decks. similarly, the contents of each space constitute part of the fuel load. Aboard cargo and tank vessels, this factor is not as critical as aboard passenger vessels due to additional amounts of passenger belongings and decor.

It has been the philosophy of the Coast Guard to design the structural fire protection regulations for shipboard spaces based upon a fuel load of 10 lb/ft^3, except for spaces containing fire-resistant furnishings. (A ten pound per square foot fuel load is roughly equivalent to a fire of 60 minutes duration.) This ten pound limit is intended to include 2.5 pounds for personal affects and 7.5 pounds for combustible furniture, furnishings, trig', drapes. And interior finish materials. Normally, calculations to determine this value are performed only if during plan reviewed it appears that the addition of fiberglass shower modules, or large amounts of combustible synthetic materials. will cause the fuel load to exceed this limit.

Aboard passenger vessels. “fire-resistant furnishings" may be used in order to utilize bulkheads and decks of a reduced insulating value, £16 CYR 72.05-10 contains tables which specify minimum requirements for bulkheads and decks. staterooms containing fire resistant furnishings' are considered type 5 spaces instead of type 6 spaces. It should be noted that where the regulations require “incombustible veneers and trim", the use of materials which are approved under 46 CFR 164.012 is acceptable.

"Fire resistant furnishings" are defined in 46 CFR 72.05-55. case furniture is required to be constructed entirely of non-combustible materials with an allowance for a 1/8” veneer of any material as the top surface. Free-standing furniture such as chairs, tables, or sofas must have frames of non-combustible materials. The frame is generally defined as the components which provide structural support. The original type chairs envisioned by the regulations consisted of a steel frame with a bottom cushion and back cushion. The materials forming the cushion could be combustible, e.g., plywood or fiberglass. contemporary furniture designs provide seating which is of modular or wrap-around construction. Chairs of this sort consist of a molded plastic or fiberglass back and bottom which is supported by a steel base. Furniture of such design does not comply with the intent of the requirement for a non-combustible frame because the molded plastic is the structural support for the back cushion. In any case, what must be considered is the total quantity of combustible materials in the seating design. When alternative designs are available, the design with the lower quantity of combustibles should be favored, regardless of frame design.

Fire-resistant draperies should be tested in accordance with tentative Coast Guard specification 46 CFR 164.011. Inasmuch as this standard is not a widely accepted standard, fabrics which have been tested to both the large and small scale tests of NFPA standard 701 will also be considered acceptable. Fabrics used on furniture intended for use in stairways and corridors of passenger vessels must also meet this standard; The padding materials used for this furniture must be "fire-resistant". Foam or other plastic paddings are considered fire-resistant if rated "self-extinguishing", or if they have a maximum extent of burning less than 122m (5 in) when tested in accordance with ASTM specification D-1692.

Table 2.5

Interior Finish Requirements

	Stairways & Corridors	Hidden Spaces	Any other bulkhead within Accommodation & Service Spaces
Tank Vessels	164.012 Material (0.75" max.)	164.012 Material (.077" max.)	Any material (.079" or 2mm max.)
Cargo Vessels	164.012 Material (.075" max.)	164.012 Material .075" max.)	Any material (2/28" max.)
Passenger Vessels	164.012 Material (.075" max.)	164.012 Material (.075" max.)	Any material (2/28" max.)*
Mobile Offshore Drilling Units	164.012 Material (.075" max.)	164.012 Material (.075" max.)	Any material (2.1mm or .083" max.)

*The total volume of combustible trim materials must not exceed an equivalent 1/10" veneer on the combined bulkhead area of each compartment.

NOTE: ASTM D-1692 no longer uses the terms "non-burning" or “self-extinguishing" because of a Federal Trade Commission (FTC) Consent Order prohibiting the use of these and similar terms that may be improperly used. ASTM D-1692 is a small scale test that has been used to eliminate the most combustible foam plastics from shipboard use. In the original test, a 2" by 6" by ½” or less sample resting horizontally on a ¼” mesh screen was exposed at one end by a fan-shaped bunsen burner flame. The flame was removed after one minute. If the sample did not ignite, it was termed "non-burning." If the sample did ignite but burned less than 5 inches, it was termed “self-extinguishing." These terms have no relationship to the traditional connotation of “non-burning" and “self-extinguishing" since they do not predict the behavior of the specimens in a real fire. However, the test does predict the ease with which a small ignition source such as a match or cigarette will cause a self-propagating fire. Therefore, ASTM D-1692 is still used by the Coast Guard as a means of eliminating the most combustible foam plastics from certain uses on vessels.

2.7 Penetrations

As previously. discussed, bulkheads and decks are designed to varying fire endurance-requirements depending upon their location within the vessel. However, once installed, they are almost always breached to allow piping, wiring, or ventilation ducting to pass through. In order to maintain an effective boundary, penetrations must be properly sealed to maintain a degree of fire endurance which is equivalent to the structural member they pierce. Due to the varying nature of protection necessary for these penetrations, each type will be dealt with separately.

Piping

As required by 46 CFR 56.01-10(d), typical bulkhead and deck penetration details must be submitted for approval. The basic design criteria for piping penetrations is contained in 46 CFR 56.50-1(a). Lead or other heat-sensitive materials (those with melting points below 1700^0F) may not be used for sealing penetrations in A-Class or steel B-Class fire boundaries. Additionally, pipe flanges may not be bolted to bulkheads to form a joint. To permit design flexibility, piping penetrations are not type approved. Final approval is generally based upon good marine practice in design and installation. For example; whenever ferrous pipe penetrates a steel bulkhead at deck, the opening around the pipe could be sealed by a tight fitting steel sleeve or alternatively, the opening could be welded. Figures 2.7.1 through 2.7.3 show typical acceptable configurations. In the event that a 3-Class bulkhead panel is penetrated, the -opening around the pipe should be kept to a maximum of 1/16 inch.

Whenever non-ferrous pipe such as aluminum, PVC, or copper alloy penetrates a steel A-0 Class division, the non-ferrous pipe must not penetrate the division, but must connect to a steel spoolpiece with an acceptable shutoff valve installed in the bulkhead.

It should be noted that shut-off valves are not permitted in vent, overflow, exhaust. or relief valve and safety valve discharge piping. In the event that any of these pipes must penetrate an A-Class boundary, they would be required to be steel or equivalent materials.

Piping penetrations through insulated steel divisions are treated as above. Additionally, structural insulation approved under 46 CER 164.007 must be applied to the piping for at least 12 inches on the insulated side of the division. The thickness of insulation applied to the pipe must be the same as the division penetrated.